Reviews and Bibliographical Notices.

I.—DURET: CEREBRAL TRAUMATISMS, &c.

ETUDES EXPERIMENTALES ET CLINIQUES SUR LES TRAUMATISMES CEREBRAUX. Par le Dr. H. Duret. Pp. 469. (*Experimental and clinical studies on cerebral traumatisms, &c.*)

This is an admirable work in many respects, and is a positive acquisition in the important and difficult department of physiology and medicine to which its statements relate. After a few judicious remarks in the way of an introduction, a short chapter is given to definitions and to a statement of the scope of the work. We cannot do better in beginning, than to extract portions of this first chapter. Says the author: "The nervous accidents caused by mechanical injuries of the brain may be distinguished as *primitive*, *secondary* and *tertiary*. By *primitive* accidents, we mean those which begin at the place and moment of the wound, or in a very short period afterwards, such as the complex pathological states, to which the names cerebral *commotion*, *compression* and *contusion* have been given.

"*Secondary* accidents are those which have their point of departure in the inflammatory reaction excited by the mechanical lesions in the midst of the nervous centres, produced by outside causes. They do not usually appear before the second or third day. Under this head we would include *meningitis*, *encephalitis*, *cerebral abscess*, &c.

"But when these phenomena have subsided or disappeared, and when the patient may even appear to have more or less completely recovered, often after months or even years have elapsed, certain disorders may manifest themselves, having their origin in the pathological residua of the traumatism and its reaction, and such are the *tertiary* accidents of cerebral traumatisms.

"As regards motion, the phenomena consist in local paralyses, hemiplegias, monoplegias of the face, eyes or members, and in certain 'contractures,' of atrophies (muscular) by descending degeneration, or even in epileptiform attacks. For sensibility, the disorders are chiefly localized anæsthesias, hyperæsthesias, neuralgias, &c., &c. In the sphere of mental action, various disorders appear, such as delirium, localized or generalized, general paralysis of the insane, monomania, suicidal insanity, loss of memory, of language, &c.

"In the first part of this work we shall be occupied in considering the pathological physiology of the primitive accidents, such as cerebral commotion, compression and contusion. If we do not mistake ourselves, great practical confusion prevails as regards the signification of these terms. We do not know as yet the exact limits of the manifestations which belong to each of these pathological entities. In the presence of a patient suffering from a cerebral traumatism, it is not rare to see an instructed and conscientious surgeon hesitate between the diagnosis of compression and contusion, or ask himself if he is not concerned with the effects of a commotion, and even after the death of the patient, the hesitation may not cease. In effect, these pathological states are superposed the one on the other, and hence complicate the case to the observer. Each of the above denominations corresponds almost always to multiple lesions, which may occupy parts of the brain the most diverse, either the hemispheres, medulla, or the cord, or the vascular or membranous envelopes of these parts.

"It seems to us, that to throw any light on this pathological complex, it is necessary to ascertain what manifestations appreciable in pathology, lesions of special parts could give rise to. We have accordingly proposed to ourselves the following questions: What is the rôle of lesions of different parts of the hemispheres, of the medulla and cord, of the dura mater and its nerves, of the cerebro-spinal liquid in the production of the primitive accidents of cerebral traumatisms?

"This analysis once made, we shall proceed to apply the results to the study of the pathological entities: commotion, compression, contusion. This is without doubt, a long and difficult work, but we have not been deterred from undertaking it. In treating such a subject, lucidity in conception, and method in exposition are equally indispensable. This is why we have indicated didactically the course we have proposed to follow. In the first we shall study successively from the point of view of the traumatism: 1st. The cerebro-spinal shock. 2d. The effects of an excess of intra-cranial pressure. 3d. The rôle of lesions of the dura mater. 4th. The rôle of vascular disorders. 5th. The rôle of lesions of the cerebral cortex and of other nervous centres, medulla, cord, &c. To this end we shall employ almost exclusively experimental researches. Experiment alone permits of clear analysis, since clinical cases are generally quite complex. In the second part we shall apply the results obtained in the explication of cerebral commotion, compression and contusion as they are conceived by surgeons to-day. Then will follow the synthesis rendered more easy by the light of experimental physiology." (Pp. 1–3.)

In the above extract is to be found the plan of this suggestive work on a subject attracting very properly a considerable measure of attention from physicians, surgeons and medical jurists, from the latter especially, in this age of railway accidents and

the like, in which, with painful frequency, there are injuries, direct or indirect, of the cord, or brain, or both, of such a nature and under such circumstances as to give occasion to troublesome litigations for the recovery of damages in case of personal injuries. But we will now pass on to give the reader an abstract of the results, with remarks on their value and on the adequacy of the methods employed in reaching them.

Shock is defined in general as follows: "The expression 'shock,' in physiology designates a phenomenon, sudden in its appearance, produced instantaneously by an external cause. This phenomenon consists generally in a sort of enfeeblement or vanishing of the functional activity of the organ attacked. *According to our view, the morbid action is not produced, only by the intermediation of the sensory nerves.* We have employed the words *cephalo-rachidian shock*, to indicate the arrest or sudden suppression of encephalic function, coming on in consequence of a blow on the cranium, and is produced by the intermediation of the cerebro-spinal fluid, transmitting the 'vulnerant' action to certain regions of the brain, capable of engendering all the phenomena observed." Again, "when we come to a study of the vascular disorders which occur in the brain, as consequences of traumatisms of that organ, we shall expose the important rôle of the different kinds of *vascular shock:* by sudden pressure (*vascular*) and the *reflex* vascular shock. The *embolic* and *hemorrhagic* varieties of encephalic shock are to be taken account of, and explained and compared with *cephalo-rachidian* shock. They constitute what may be called *medical* shock, while the former varieties (cephalo-rachidian) may be called *surgical.*

"There exists, finally, a *nervous shock*, properly speaking, in which no liquid intervenes. It is when a sensitive nerve (injured), by an action of arrest suddenly diminishes or suspends the action of the brain or higher nervous centres. Such is sometimes the action of the brain on the cord, of the pneumogastric nerve on the heart. The *cephalo-rachidian* shock, which is the principal object of our studies, has never been, we believe, indicated and explained until the present." (Pp. 4, 5.)

Dr. Duret denies that the multiform and grave phenomena of shock, as he describes it, can be produced in the way ordinarily supposed, viz.: that of a hypothetical molecular disturbance, not often manifest to the microscope, and resulting from external violence to the cranium. He gives pretty good reasons for the positions he assumes. Neither can we find an explanation of the phenomena in question by a rational appeal to even the most recent physiological notions concerning the rôle of the hemispheres. In the lower animals, the hemispheres may be contused, lacerated, or even wholly removed, without producing the phenomena of shock. To a certain extent, the same statement applies to man. But the symptoms of shock are often manifested when there are very inconsiderable lesions of the brain, or even none at all to be

found after death. Then how shall we explain cerebral shock? Its most common and characteristic phenomena are *sudden partial arrest of respiration, and of the heart's action, followed by disturbance*, or even *loss of consciousness.* Dr. Duret would refer these phenomena to an injury of the medulla rather than the brain. In it lie the cardiac and respiratory centres. The exact mechanism of these consequences is explained farther on in the work. But how explain the disturbed mental action? The author would explain it on the one hand, by postulating lesions of the nucleus of the hypoglossus, and of other of the motor cranial nerves, in such way as to obscure or prevent the *expression* of the workings of the mind, and on the other hand, by cutting off the sensory tracts in the medulla, which convey impressions from the outer world to the cerebral cortex. And so between the cessation of mental action, which it is *assumed* would result from cutting of its communication with the outer world, and the impossibility of expressing either thought or emotion, by reason of a paralysis of the nervous apparatuses involved in their expression, the individual is either actually unconscious, or at all events *appears* to be so to the outward observer. In the support of these views, Dr. Duret enters into certain discussions, into which it is our purpose briefly to follow him, all the more so, as we believe them to be in great measure erroneous.

"What is Life?" says he. The reply is as follows: "It is in the animal the reaction of the nervous centres under influences which are being or have been transmitted to them by the sensitive nerves, sensorial or vegetative."

In stating the relations of mental action and development to the exterior nervous apparatuses and external world beyond them, he remarks: "In one word, *we owe to the external world* the life *intellectual and voluntary, that is to say, the life of relation; and the vegetative life does not appear and is not developed except by excitations from centripetal conductors.* Hence, it is easy to understand that if these two orders of relations with the external world are abolished by the destruction of sensitive fibres, that life is extinguished." If these assumptions were anything more than partly true, we might expect *a priori*, that the central nervous apparatuses to which sensory nerves go, especially in the higher parts of the nervous system, would be necessarily in a very imperfect state at birth, or until exposed to sensorial excitations from the outer world. This view, which is by no means novel or uncommon, is the one adopted by Dr. Duret. He refers to his own valuable researches (*Archives de Physiologie Norm. et Path.*, 1874 and 1875,) on the circulation of the brain and on the cerebral functions, to show that the structure of the brain is so imperfect as to strongly support his views concerning the absolute dependence of the brain and higher parts of the central nervous system for its existence and development on excitations from the external world by way of the sensory

nerves. Sander, Soltmann, Rouget and Munk are quoted in support of his position. But we can go no farther than to say that we thoroughly disagree with the author in respect to the validity of the assumptions at which we have glanced. His statements are tissues of error and truth, not even skillfully combined. They do not have even the merit of novelty. His definition of life is partial and faulty, as it would be easy to show. His dictum as it stands, as to the absolute dependence of the central nervous system for its appearance and development, is contradicted by facts at all points. Take for example the chick in the act of escaping from its shell, with its head just out, and in a few minutes opening its eyes and *seeing* an insect on a blade of grass within its reach, and picking it off with precision and swallowing it; or take the young serpent, as we have seen, let out of its egg-case by cutting it open with a pocket-knife, and which, when liberated, immediately ran and hid itself beneath a clod. But not to multiply cases even among the higher animals, we would refer to the papers just published of Tarchanoff,* in the last two numbers of the *Revue Mensuelle*, and in which he shows that in many animals, even the cortical motor centres are developed before birth, as was proved by examinations, anatomical and physiological, of young animals, both immediately after birth *and before it.* In such cases the central nervous apparatuses, which, according to others as well as M. Duret, can only be developed after the nerves leading to them have been the seats of excitation in their peripheral ends, are found to the contrary to have been developed in the absence of this prime condition.

Then again, in explaining how it comes to pass that affections of the medulla disturb the mental functions, the author does not seem to us to have arrived at a just conception of their *modus agendi.* But we may find occasion to return to this topic a little later.

Dr. Duret began a series of experiments on animals, especially rabbits, which consisted partly in the injection with some force into the cranial cavity through a small hole, on the *surface* of the brain, certain quantities of water, or other liquids, after which the animal immediately died. The post-mortem showed rupture of the brain from the great ventricular cavity *outward* through the substance of the hemispheres, and also distension of the Sylvian aqueduct and medulla. Upon considering these cases, especially those unexpected lesions, the author says: "A luminous idea suddenly rose in my mind. This distension of the medulla, this rupture from within outwards, this dilatation of the aqueduct of Sylvius and of the central canal, had been produced by the enormous tension of the *cephalo-rachidian* fluid. Under the influence of sudden and severe pressure exerted on the surface of the hemispheres, the very large quantity of the cerebro-spinal

* J. de Tarchanoff: "Sur las Centres Psycho-Moteur des Animaux Nouveau né et Leur Developpement dans Differentes Conditions," *Revue Mensuelle*, October and November, 1878.

fluid contained in the lateral ventricles had been rapidly driven out, being made to traverse under pressure, the aqueduct of Sylvius into the fourth ventricle. The aqueduct of Sylvius was dilated and torn. The fourth ventricle receiving *suddenly* an enormous quantity of fluid, which could not find easy escape by the central canal, or by the foramen of Magendie, the fourth ventricle had become to such a degree distended as to burst. At the same time there was dilatation of the central canal, of the spinal cord, and of Magendie's cavity." (P. 11.)

According to the opinion of Dr. Duret, this mode of accounting for some of the immediate consequences of cerebral traumatisms was one of the most important discoveries made in the course of his researches. In order to avoid some actual or possible objections to his experiments and the deductions from them, they were varied in many respects, until it appears that we may accept both with a good degree of trust. The same kind of gross lesions were often found to result from sudden blows on the head without the injection of fluid into the cranial cavity. By them Dr. Duret would explain in many cases sudden death following blows on the head, and many other grave conditions so resulting, which are not at once or at all fatal. And this is briefly the *cephalo-rachidian shock* of our author, and on which he very properly lays much stress.

In order to render his dicussion intelligible, Dr. Duret gives a very clear *resumé* of researches, up to date, regarding the system of lymph-spaces and channels about and within the brain. Beginning with the larger subarachnoidal spaces beneath and about the brain, filled with fluid and called "lakes" (*lac* sylvien—*lac* cérébelleux inferieur—*lac* cérébelleux superieur), these spaces are traced outwards along the larger fissures (which centre at the "lakes"), such as the *Sylvian* fissure, and which are called *fluminæ*, and these to smaller fissures branching from the larger ones and called *rivi*, and from these again to still other and smaller fissures, branching from the *rivi*, called *rivuli*. From these finally, there are small branching tunnels, so to speak, in the nervous substance, which the arteries enter and follow to their final terminations in the capillaries. The vessels do not fill these tunnels in the brain substance, the space they do not fill being occupied loosely by delicate connective tissue, the meshes of which are filled by the "cephalo-rachidian" fluid, which distends not only the spaces about all the vessels in the brain substance, but in a regressive order also the "rivuli," the "rivi," the "fluminæ," converging thus from every direction on the central reservoirs of the "cephalo-rachidian" liquid, in the "lakes" or subarachnoidal spaces beneath the brain. These same lymph-spaces may be traced around and into the medulla and cord, and along the sheaths of the nerves, especially the cranial, and among them, most evidently along within the sheaths of the olfactory, auditory and optic nerves, even in one case to the perilymph in the labyrinth, and in another to the

liquid which fills the space within the globe of the eye, in front of the lens. The same spaces filled by the same liquid may even extend along the spinal nerves, within their sheaths, to their peripheral ends.

We thus have a most comprehensive and penetrating system of lymph-spaces, extending from the great "lakes" or subarachnoidal spaces beneath the brain, in one direction down the cord and peripheral nerves, cranial and spinal, and in the other, a system of branching lymph-channels, penetrating the brain substance by successive divisions, until they reach in microscopic fineness the ultimate fibres and cells of the brain. Cerebro-spinal fluid (lymph) and delicate connective tissue webs, go hand in hand through a complex system. Our knowledge of this system of lymph channels has mainly resulted from the researches of Robin, His, Schwalbe, Axel Key and Retzius, Golgi, Ranvier and many others, including in the list the author of the present work.

Dr. Duret speaks of the use of the cephalo-rachidian liquid as follows: "Its principal physiological use, is to preserve the nervous elements against cardiac shock, or the excess of vascular tension, not only of the elements in the nervous centres, but even in the nerves and nervous parts of the organs of sense. If the tension of the blood is augmented a more considerable quantity of the liquid is exuded, and if the subarachnoidal spaces do not deplete the lymph channels, cerebral œdema results, as may be observed in certain cases of inflammatory reactions provoked by traumatisms. The tension of this liquid exceeds the pressure of the atmosphere, as has been proved by decisive experiment. It plays, according to our author, an important part in cerebral shock. He says: "Can a displacement of parts (of the brain and medulla) be produced under the influence of shock? The answer to this question is affirmative, if the cranium is elastic, and if the cerebro-spinal fluid has a way for momentary escape from the cavities it occupies." In case of a shock, especially, received on certain parts of the cranium, there always occurs "a sudden distribution of the shock or gross impulse to all those regions to which the cerebro-spinal liquid circulates. Under the influence of the sudden pressure, the liquid is expelled from the 'lakes' into the 'fluminæ,' from these into the 'rivi,' and from these again into the 'rivuli,' and finally" the impulses are propagated along the liquid which fills the lymph-spaces about the vessels, onwards to their final ramifications amid the nervous elements. "Thus we may explain the thousands of small vasal ruptures permitting small hemorrhages, which as consequences of shock, are strewn in the nervous substance, in the most divers places." To this it seems to us the author may have added, that there are also under the circumstances given, delicate and wide-spreading ruptures of the nervous elements one from another, independently of the hemorrhages, as well as caused by them. The physical conditions of

the case render such a deduction almost a necessary one. The author does not overlook this phase of the subject. He has not, however, insisted on it, as it deserves.

Starting with the fact, that the cranium is elastic, and temporarily changes its form when struck, he recites the results of a number of experiments on crania filled with paraffine, instead of brain substance, and they are of considerable interest to those who desire to study intelligently the physics of localized mechanical violence, done to the cranium and its contents. But we cannot go into this subject at present. And we have given so fully the views of Dr. Duret on the subjects just mentioned, because they are of great value to the physician, surgeon and medical jurist. They afford us a rational statement of the nature and results of "cerebral shock" resulting from traumatisms.

After this more general part of the work, Dr. Duret begins a detailed study, into which we may profitably follow him. In the first place a "physiological explanation of the lesions produced by the cephalo-rachidian shock," is given. Although it will in some measure lead us over the same ground that we have already traversed, yet we shall find much of interest to our readers who may not have seen the work itself. The first generalization made, is that "the lesions produced by the shock, *occupy principally the spaces where the cerebro-spinal fluid circulates.*" These lesions are divided into two classes, "superficial" and "interstitial." Among lesions of the first of these classes, those of the convexity of the hemispheres are first described. In case of a blow on the cranium, the resulting lesion (superficial) "may occupy the point percussed, or the opposite extremity of the axis of percussion, that is to say, corresponding either of the *cone of depression* [cône de depression] or *cone of elevation or projection* [cône de soulevement]." The former is the depression of the elastic cranial wall, at the point where the blow is struck, the latter being the sudden *projection* of the same cranial wall, at the side opposite to the one occupied by the "cone of depression." The lesions at the "cone of depression," where the cranial wall is driven in on the brain substance, are mostly of a gross surgical character. But not so those which occur at the "cone of projection," which is carried away from the brain substance, as it were. In explaining these latter lesions, Dr. Duret says: "We do not admit the doctrine of lesions by *contre-coup*, as it is formulated by classic authors." He explains these lesions as follows: "The lesions observed at the remote extremity of the axis of percussion, opposite to the point percussed, are the result of the action of the "cone of projection." It creates suddenly a void, and aqueous and sanguine liquids are suddenly driven into it to fill it, and then result ruptures of vessels, and blood phlyctænulæ *beneath the pia mater.* That which goes to confirm our opinion, is a study of the appearance of these lesions. They occupy an oval-shaped space, sometimes circular or elliptical, corresponding to the base of the *cone of projection*, and their maxi-

mum is at the centre of this base." (P. 38.) These lesions are then described and figured in various plates at the end of the volume. But we cannot now enter farther into their consideration.

The mode of occurrence of "lesions of the hemispheres at their base," is described as follows: "Lesions of the base of the hemispheres are very frequent and very pronounced, because there we find the 'aqueous lakes'—the *Sylvian*, which in blows on the vertex, support the momentum of the shock. In effect, in a stroke on the head, on the most convex part of the head, all the vertex constitutes the cone of depression. At the opposite extremity of the axis of percussion, there is in this case no cone of projection, on account of the firmness of the base of the cranium. The cerebro-spinal fluid, being driven from the convexity flows towards the 'lakes' at the base of the brain, and produces a sudden inundation of surrounding territories. The peripeduncular canals are far from being sufficient to accommodate so violent an irruption of fluid. The small vessels which traverse the 'lakes' are ruptured, the neighboring parts are inundated by blood, and at times the nervous substance is involved, and its structure destroyed by the violence of the flood. In certain cases, the visceral layer of the arachnoid is lacerated, and blood mixed with cerebro-spinal fluid fills the cavity of the arachnoid, either ascending in the same towards the convexity of the hemispheres, or what is more frequent, descends between the two layers of the arachnoid, around the peduncles, pons and medulla. It is remarkable to observe how faithfully the hemorrhages occur in, and outline the scheme of the 'lakes,' as already described. In the dog [killed by a stroke on the head] for example, the *Sylvian* and *central* 'lakes' and the peripeduncular canals, are already outlined by the hemorrhages, and on the confines of these lymph-spaces may be seen the localized hemorrhages, radiating along the 'flumina,' and beyond to variable distances, and at times penetrating the nervous substance." (Pp. 39, 40.)

Similar vascular lesions and frequently ruptures of nerve trunks, or of the nervous substance of the peduncles, pons and medulla also occur. The spinal cord, even down to the lumbar region, does not escape these vascular lesions.

Dr. Duret next gives detailed attention to lesions of the ventricular cavities resulting from blows on the head. He says: "One general fact must be made prominent in the outset, namely, that in case of a blow on the head, a *wave of percussion* is produced in the ventricular cavities. * * * The ventricular wave produced by the percussion is always more decided if the violence is exerted on the forehead or vertex. Under such circumstances a very voluminous *cone of depression* is formed, especially if the percussing body has a large surface. The ventricular cavities are then suddenly effaced, and the wave of liquid (ventricular) engages with all the more violence, since a

cranial *cone of projection* is not possible. The liquid traverses the aqueduct of Sylvius, and is hence violently driven into the fourth ventricle. From this it passes by the foramen of Magendie, which is torn if not very large, and rushes farther on into the posterior cerebellar 'lake,' and under the medullary and spinal pia mater. The lesions of the medulla, in the commotion, occupy principally the posterior parts of the lateral ventricles, the aqueduct of Sylvius, that part of the medulla which corresponds to the fourth ventricle, especially its inferior parts, the foramen of Magendie is ruptured, and the central canal of the spinal cord receives part of the wave of fluid, which often results in violence. Clots of blood fill more or less the ventricular cavities in the walls of the same and in the floor of the fourth ventricle, especially in company with lesions of the nervous substance in the lower part of the floor of this ventricle. At the moment of the violence, two liquid waves are started, the one external to the brain (peripherique), the other from the interior (cavitaire), which both pass towards the foramen magnum, and which converge at that point to produce the principal lesions, caused by violent movements of the cerebro-spinal liquid, as might be expected *a priori*. These lesions are described at length by Dr. Duret, and duly illustrated by colored drawings at the end of the volume. But we will postpone the remainder of our notice of this interesting work to the next issue of the JOURNAL, in which other and even more interesting parts will be fully noticed on account of their practical importance, not only for the physician, but also for the surgeon and medical jurist.

(*To be continued.*)